Active Project (2014 - 2017)

Balancing Autonomous Spacecraft Activity Control with an Integrated Scheduler-Planner and Reactive Executive, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

Spacecraft and remote vehicle operations demand a high level of responsiveness in dynamic environments. During operations it is possible for unexpected events and anomalies to disrupt the mission schedule, and in the case of critical faults, even threaten the health and safety of the spacecraft. The planner's relatively slow response time to unexpected events (changes in resource levels, failed activity indications, flight software fault indications) during dynamic and critical operations means that it does not suffice as a sole solution to the vehicle autonomy when the primary purpose is to keep it safe and ensure mission success. Mission success can also be enhanced through the use of a sequence engine that provides reactive capabilities. Traditional sequence engines execute commands without regard to the overall safety of the vehicle. Through the use of a reactive sequence engine that utilizes State Machine technology vehicle further enhances safety and the probability of mission success. The Integrated Scheduler-Planner And Reactive Executive (I-SPAREX) architecture utilizes a layered software architecture (an approach proven successful on previously flown autonomous demonstration missions such as EO-1) and incorporates an existing goal-based, planning solution as well as an advanced, real-time, decision-making sequence engine. Specifically, we plan to study and demonstrate the feasibility of integrating NASA JPL's CASPER (Continuous Activity Scheduling Planning Execution and Re-planning) as the Continuous Planning Layer (CPL), and VML 3.0 (Virtual Machine Language) as the Reactive Sequencing Layer (RSL) providing programmable heuristic control. We choose to focus on CASPER and VML in this proposal, given the demonstrated flight heritage of both components.

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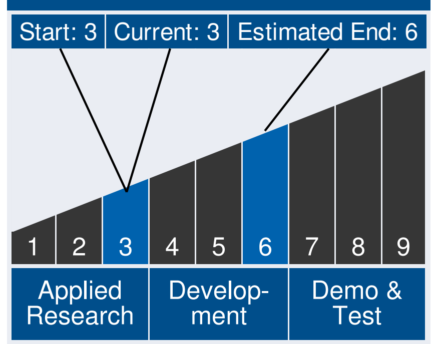
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

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ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: I-SPAREX architecture is directly applicable to all NASA onboard spaceflight operations. This includes LEO, Near-Earth, and especially Deep Space Missions. Any mission that requires remote autonomous operations can utilize this technology. Examples of these types would be rovers, planetary science, and asteroid science.

To the commercial space industry:

Potential Non-NASA Commercial Applications: After this architecture and implementation is demonstrated on a functional spacecraft simulator, it will find a number of military, commercial, and commercial applications. These include: a) Surveillance and intelligence missions, b) UAV operations, c) Autonomous Underwater vehicles, Autonomous land vehicles, and e) remote commercial operations such as oil fields. The Red Canyon Team predicts that our proposed work of integrating the planning environment with the real-time execution software will have far-reaching commercial and R&D applications. For instance, the entire range of remotely operated vehicles, to include: - Remotely Piloted Vehicles (RPVs) (a.k.a. Unmanned Aerial Vehicles (UAVs)) - Remotely Operated Underwater Vehicles (ROUV) - Remotely Operated Ground Vehicles (ROGV) (a.k.a. Unmanned Ground Vehicles (UGV)) - Tele-Robotics, in general would benefit greatly from this integrated environment. RPVs in the National Airspace (NAS), as one example, could capitalize on the fault-tolerance, model validation, and the dynamic/evolving shared model concepts that are developed here. Red Canyon Software has already been involved in discussions with ADSYS Controls, a company experienced with the development of RPV flight control systems, to determine the commercial application of our proposed system.

Management Team *(cont.)*

Program Manager:
- Carlos Torrez

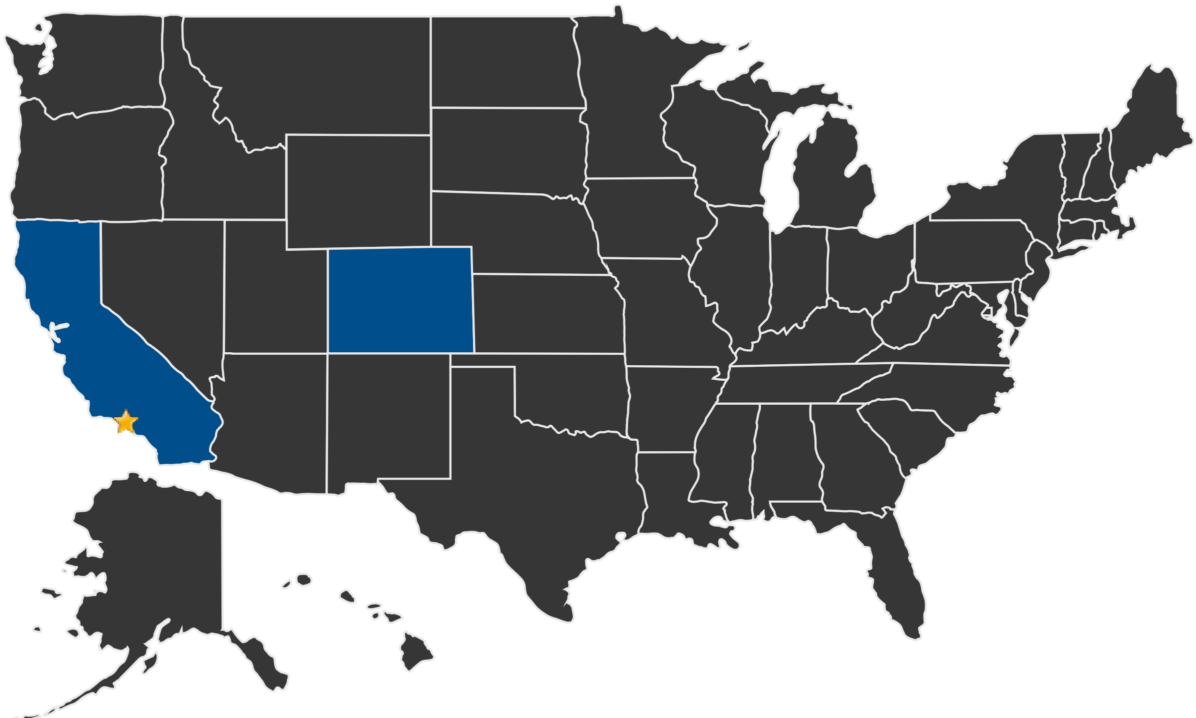
Project Manager:
- Robert Jones

Principal Investigator:
- Caroline Chouinard

Technology Areas

Primary Technology Area:
Modeling, Simulation, Information Technology and Processing (TA 11)
└─ Information Processing (TA 11.4)
  └─ Advanced Mission Systems (TA 11.4.5)
    └─ Mission Planner/Monitor (TA 11.4.5.1)

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Jet Propulsion Laboratory

Other Organizations Performing Work:

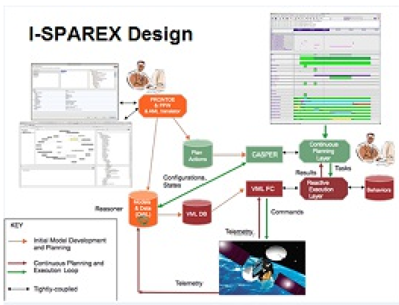
- Red Canyon Software (Denver, CO)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23080)

IMAGE GALLERY



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DETAILS FOR TECHNOLOGY 1

Technology Title

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